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ABSTRACT

A unit on submerged arc welding (SAW) was developed and integrated into the welding program at Seattle Central Community College (Washington) during the period December 1983 through May 1984. During this time, 10 major users of SAW in the area were contacted and mailed questionnaires. Follow up consisted of telephone calls and personal contact as necessary. From the responses gathered, behavioral objectives were formulated. Equipment possibilities were investigated and the Union Carbide LINDE unit was chosen. The LINDE unit was installed and put in use after a half-day training session provided by the manufacturer. Four students who were high achievers in the welding course were introduced to SAW, instructed in the use of the process and of the particular equipment, and given a short reading assignment. They then used the equipment in the SAW process. Seven other students then were trained in the process. As a result of this project, submerged arc welding is now a viable part of the training program at Seattle Central Community College, the staff is more up-to-date with current technology, a new member of industry is joining the advisory committee, and vital supportive links with industry have been established. (KC)

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IMPLEMENTATION OF SUBMERGED ARC WELDING TRAINING

FINAL REPORT

Project No. 84-ATP(151)NB

Curriculum Development Project
Conducted Under Public Law 94-482

Dr. Earl Bowick, Project Director
Seattle Central Community College
Trade and Industrial Division
1701 Broadway 2BE 0106
Seattle, WA 98122

June 4, 1984

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RESEARCH COORDINATING UNIT
Washington State Commission for Vocational Education

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SUMMARY

The report describes activities by the principal investigator, John Todd, of Seattle Central Community College's Welding Department which led to the "Implementation of Submerged Arc Welding (S.A.W.)" into the training program.

Activities began in December, 1983, and continued until May 11, 1984, by which time twelve (12) students had been trained in S.A.W.

The training objectives included identification of equipment, correct setup and adjustment of equipment, and performance with equipment in making and evaluating butt and fillet welds.

The course of action is best described by reference to the time line. (See Appendix A) In general, the time line proved to be realistic with two exceptions. The first major activity of formulating specific behavioral objectives did take more time than estimated and required some follow up trips to obtain the needed information. It was not until the middle of February that all of the questionnaires were completed. The other major deviation from the time line was in the set up and use of the equipment. The relative ease in completing this portion can in large part be attributed to the effectiveness of the vendor, Welders Supply Co., of Seattle, in providing the instructors with all the technical assistance that was required.

The unplanned hours spent with unforeseen difficulties in obtaining a realistic industry input were pretty well offset by the relative ease of training commencement.

On April 9, 1984, history was made at Seattle Central Community College when the first group of four (4) students successfully completed their training in S.A.W. This achievement was followed by a second group of seven (7) students. Submerged Arc Welding is now a reality at SCCC. The chairman of the Welding Advisory Committee, the Trade and Industrial Division Chairman, and the Dean of Instruction with the District Chancellor have all seen the unit in operation.

Hindsight is, of course, quite accurate but if a similar project were attempted in the future, a team would possibly have been able to obtain the industry input more quickly. Yet, the project is on line and the conclusion is that of encouragement to both the principal investigator and his colleagues in the Trade and Industrial Division at Seattle Central Community College.

REPORT

Early in January, 1984, the Welding Advisory Committee was first contacted regarding the possible introduction of a training unit in Sugmerged Arc Welding (S.A.W.). This was done individually over the phone and the response at that time was to pursue it. I was told that S.A.W. is being used extensively by industry now and will continue to be used into the foreseeable future. Because of the inherent advantages of no smoke and no arc flash, the use of S.A.W. had increased in recent years. It was generally pointed out that students of welding should at least be introduced to S.A.W. as part of a comprehensive training program.

A questionnaire was prepared and sent to the ten (10) major users of S.A.W. in the region. (See Appendix B) The responses either came easily or were "like pulling teeth". I persisted via telephone and travel when necessary and used the information regarding suggested student exercises to formulate behavioral objectives. (See Appendix C)

It was time to look at the equipment possibilities and three major manufacturers were considered, viz., Lincoln Electric, Hobart Brothers, and Union Carbide (LINDE). The Linde system offered the most benefits besides the best price. Union Carbide is the world leader in production and sales of S.A.W. consumables. This unit would also interface readily with existing equipment of the same manufacture. Several trips to job sites and conversations with welders and foremen confirmed the quality and advisability of the Linde unit. By late February the equipment had arrived. (See Appendix D for description)

A half-day-plus training session by the vendor answered any process-related questions and provided a shake-down operation. Thus, by February 26, 1984, an operable unit was ready for instruction. Some student instruction was begun this date in the form of equipment familiarization. The unit proved to be a particularly interesting object to the students and prompted independent research on the part of several students. On February 27, 1984, a workshop was held in the Wirefeed Lab for the rest of the welding training staff.

Class size for the Gas Metal and Flux Core Arc Welding course is 16. The initial quarter is usually more than taken up with the Gas Metal and Flux Core processes using carbon steel metal. Aluminum and stainless steel are left for the second quarter which also includes an opportunity for the student to construct a project. Eventually this second quarter will be the time frame in which the student can spend at least one week exploring the S.A.W. process and gaining experience and confidence.

On May 9, 1984, a group of four students who were high achievers with the laboratory projects were introduced to S.A.W. within the regular laboratory time. They were instructed on the use of the process and of the particular equipment and

given a short reading assignment for homework. On May 10, 1984, these students were instructed to conduct an experiment with a square butt joint using 3/8 inch steel plate (per industry suggestion). The first joint was welded with 300 Amperes and 32 Volts. (See Appendix E for Parameters). Incidentally, there are no published parameters available in any of the 13 welding textbooks which I consulted, so the industry suggestions provided a most helpful starting point. Within six hours all four students had successfully completed setup, welding, and testing the plates by the S.A.W. process. The plates were cut across the welds and the weld zones polished and checked for surface defects by the Dye-penetrant Process. (See Appendix F for photo)

In addition to the four students mentioned above, seven other students who had completed the course but were still in the department, were brought back for a four-hour experience. The results were equally gratifying.

The primary textbook material for this learning unit was Howard Cary's Modern Welding Technology, Section 5-2, "Submerged Arc Welding". The information from Todd Pacific was most helpful as it describes approved U.S. Navy welding procedures using this process. A set of training slides will be made soon to better introduce the S.A.W. process to future students.

A word should be said about an unexpected benefit which came with the pursual of the questionnaire. Considerable rapport was developed with several of the industrial users of S.A.W. They were able to see that our school is interested in providing relevant training and gratified to learn that our students were being so well prepared. We have placed three of our students with these users and one shop foreman has volunteered to serve on our Advisory Committee and to assist in providing additional workmanship samples.

In summary, Submerged Arc Welding is now a viable part of the training program at Seattle Central Community College, our staff is more up-to-date with current technology, the Advisory Committee has promise of "fresh blood", and some vitally supportive links with industry have been established.

APPENDIX

A - Time Line

B - Questionnaire

C - Behavioral Objectives

D - Equipment Descriptions

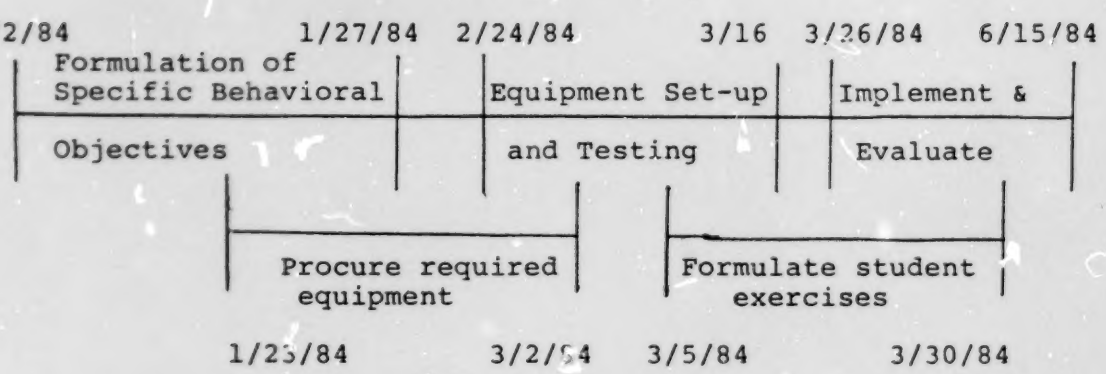
E - S.A.W. Parameters

F - Photos

G - Credits

A Time Line

Program and Schedule of the Proposal



1/2 to 1/27 Formulation of specific behavioral objectives with members of Advisory Committee and principal users of the process. Vendors of welding supplies will locate the principal users. This phase will necessitate some travel and phone calls.

1/23 to 3/2 Procure required equipment via established closed bid process. Also, some consumables, e.g., electrode and flux have been already gathered through vendor donations.

2/24 to 3/16 Equipment set up and testing within the welding training laboratory to involve both hand-held and fully automatic travel modes on various joint designs and material thicknesses - construct workmanship samples.

3/5 to 3/30 Formulate student exercises - add specific operations to student list of jobs to perform - workmanship samples to illustrate desired results in step-by-step fashion.

3/26 to 6/15 Implement and evaluate with Spring, 1984 students. Establish what percentage of total students in class successfully complete objectives. Review and modify and reevaluate as required.

B - Sample Questionnaire

Dear

We are about to start an instructional unit in Submerged Arc Welding and value your assistance.

What would be the most informative/productive exercises for the student to perform? For example, what joint, position, etc.?

We are normally limited in the school lab to short runs of 36 inches or less and plate thicknesses of 1/2 or less.

Please respond as soon as possible.

Thank you.

Sincerely

John Todd, Welding Instructor
Trade and Industrial Division

JT:jm
Enclosure: Return Envelope

seattle central community college
1701 Broadway • Seattle, WA 98122 • (206) 587-3800

C - Behavioral Objectives

Training in S.A.W. will enable the student to:

1. Identify the equipment items required for S.A.W.

2. Properly (safely) connect and set up the components of the SAW system - electrical, wire feeding, and flux systems.

3. Perform several test welds on flat plate with changes in the variables of voltage, wire feed speed, electrical stickout, gun angle, and travel speed.

4. Recognize problems caused by improper use of the five variables mentioned in No. 3.

5. Weld 3/8 carbon steel plates with a square butt joint and 0 root opening in the flat position.

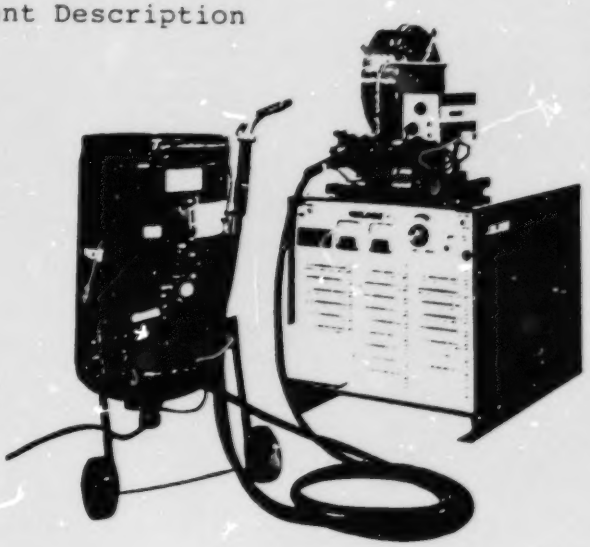
6. Demonstrate the proper use of run-on and run-off tabs.

7. Weld 3/8 carbon steel plates with a T-joint in both the flat and horizontal positions.

8. Demonstrate mastery of the principles of S.A.W.by sucessfully answering 80% on a written quiz.

9. Demonstrate the proper method of equipment "knock down" and storage including provision for wire and flux protection from moisture and foreign matter.

D - Equipment Description



FEATURES/BENEFITS

- a better welding environment — with virually no smoke or exposed arc, a welder can enjoy a more comfortable welding environment which translates into greater operator duty cycles with no helmet or leathers required
- high deposition efficiency — because there's no weld spatter, 100% of the wire purchased is converted to weld metal; the best of any manual welding process
- high productivity — a clean and comfortable process, offering high deposition rates and efficiency at increased travel speeds, results in the lowest total welding costs
- easy to operate — the UMA-2 torch is handled and manipulated in a manner similar to a mig torch, so minimal operator retraining is required
- versatile — combined with the MIG-35 feeder and LINDE 650 power supply, the UMA-2 package provides the ability to do single or multipass butt, fillet and lap welds, with 5/64 wire, up to 600 amps
- "E-Z" feed torch design — the UMA-2 torch utilizes a 5/6 in. I.D. flux feed assembly and 60° neck angle to assure consistent flux feeding in even the most demanding circumstances
- lock-in trigger — allows operator to release torch trigger during welding; increases operator comfort and performance during long welds
- one piece composite power cable — allows torch to be strong, lightweight and durable
- competitive wire feeder adaptor kits — the availability of adaptor kits provides versatility by allowing the UMA-2 package to be utilized with competitive wire feeders
- ease of maintenance — the UMA-2 torch's simple patented design uses one clamp to hold the power cable, neck flux tube, switch, and handle together
- low pressure 200 lb. mobile flux tank — "E-Z" feed flux delivery design allows for consistent flux feeding at lower operating pressures (15-25 psi)
- 200 lb. flux capacity — twice that of competition — enables operators to weld twice as long between refills
- regulator/filter assembly — provides the ability to quickly adjust operating flux feed pressure, while the in-line air filter acts to eliminate water from the air source and reduce the possibility of flux/moisture pick-up
- built in flux funnel and screen — allows for quick and easy refilling made easy with a patented fill plug — use LINDE wire and bonded (231, 350, 429) or fused (80-709-5-124) fluxes for best results — only Linde offers both
- easy to order — order one part number to get the basic UMA-2 package or; "one part number gets it all" when ordering the complete UMA-2 package with MIG-35 wire feeder and LINDE 650 power supply
- warranty — only Linde offers you all these features and this performance under simple package part numbers, and stands behind equipment with the best warranty in the industry

SPECIFICATIONS

UMA-2 Torch	
Length of Service Lines	15 ft (4.5 m)
Handle Diameter	1-3/8 in. (35 mm)
Welding Wire Size	5/64 in. and 3/32 in.
Max. Welding Amp	600 Amp Continuous Duty
Flux Tank	
Height	38 in. (965 mm)
Diameter	16 in. (406 mm)
Capacity	200 lbs. (90 kg)

ORDERING INFORMATION

$ 584,85

Basic UMA-2 Welding Package ..... **P/N 600311**
Complete UMA-2 Welding Package ..... **P/N 600312**

Consisting of:	Basic UMA-2 P/N 600311	Complete UMA-2 P/N 600312
UMA-2 Torch Assy.	999350	999350
UMA-2 Flux Tank Assy.	677761	677761
(2) 5/64 in. Contact Tube	999351	999351
15 ft Flux Hose	999349	999349
(2) Hose Clamp	96W37	96W37
Air Hose Adaptor	639046	639046
LINDE 650 P.S.	—	677910
MIG-35 Wire Feeder	—	953552
Std. Wire Reel Assy.	—	995570
5/64 in. Serr. Feed Roll	—	2075261
Cable, 6 ft/4-cond. Pwr. Supp. to Wire Feeder	—	996735

E - SAW Parameters

Cable "Robin" New York

TODD PACIFIC SHIPYARDS CORPORATION

Seattle Division: P. O. Box 3806, Seattle, Washington 98124 Tel. 623-1635 (Area Code 206)

March 20, 1984

John Todd, Welding Instructor
Trade and Industrial Division
Seattle Central Community College

Dear John,

I am sending you a copy of Todd Welding Procedure TWPS 1506. This Procedure was developed for Submerged Arc Welding for the present FFG Program at Todd Pacific Shipyard. Although most of our Sub Arc Welding is done with Mechanized Welding Equipment I hope that this Procedure will be helpful as a guide. If you need additional information on Sub Arc Welding you might contact Mr. Harry Dame; Technical Representative for Lincoln Electric Co. at 767-4743.

Sincerely,

Jim Johnston

Jim Johnston
Welding Engineering Dept.
Todd Pacific Shipyard

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A SUBSIDIARY OF TODD SHIPYARDS CORPORATION
Executive Offices: One State Street Plaza - New York, N. Y. 10004

E - SAW Parameters

WELDING PROCEDURE SPECIFICATION DEPARTURE	WPSD NO. PAGE 1 OF 4	RELEASE DATE	TWPS 976-1506 PAGE
☐ DEVIATION ☒ VARIATION			
REASON: (1) To permit use of Type MIL-B1 Electrode. (2) Increase material thickness qualification limit.	ORIG. 6-6-66. WELDING ENG. PRODUCTION OPN MGR	TWPS TITLE:	
SUB-CONTRACTOR(S) AFFECTED	CN SHIPS	TODD SHIPYARDS CORPORATION SEATTLE DIVISION	

Para. 1.1 Scope

Increased material thickness limits from (1/8 to 1 inch) to (1/8 to 4 inches).

Para. 2. Table of Contents

Add Supplement 4, 5, 6.

Para. 4.2 Filler Material

Add following material:

Specification	Type	Size
MIL-E-18193 A	MIL-B1	1/16" maximum diameter

APPROVED:

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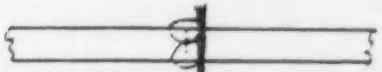
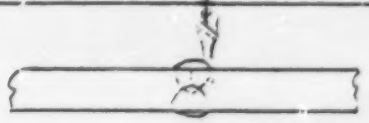
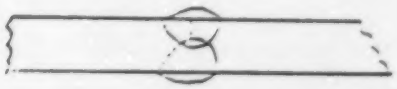
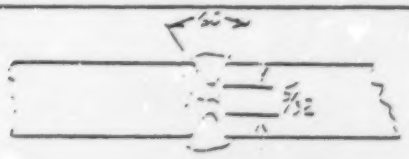
E SAW Parameters

Joint Design & Material Thickness	Pass No.	Current Amps	Voltage	Travel Speed IPM
3/16 	1 / 2	300	39	40
1/4 	1 / 2	450	43	34
3/8 	1 / 2	450	43	28
1/2 	1 / 2	450	43	22

Variation from the operating parameters specified above shall not exceed ± 10% for current and travel speed, ± 2 volts for voltage.

Electrode - Type MIL-B1
Flux - Type MIL-F2

BUTT WELD PARAMETERS

1/16" DIA. WIRE

SUPPLEMENT #4

TWPS
976-1506

WPSD #1
PAGE 2 OF 4

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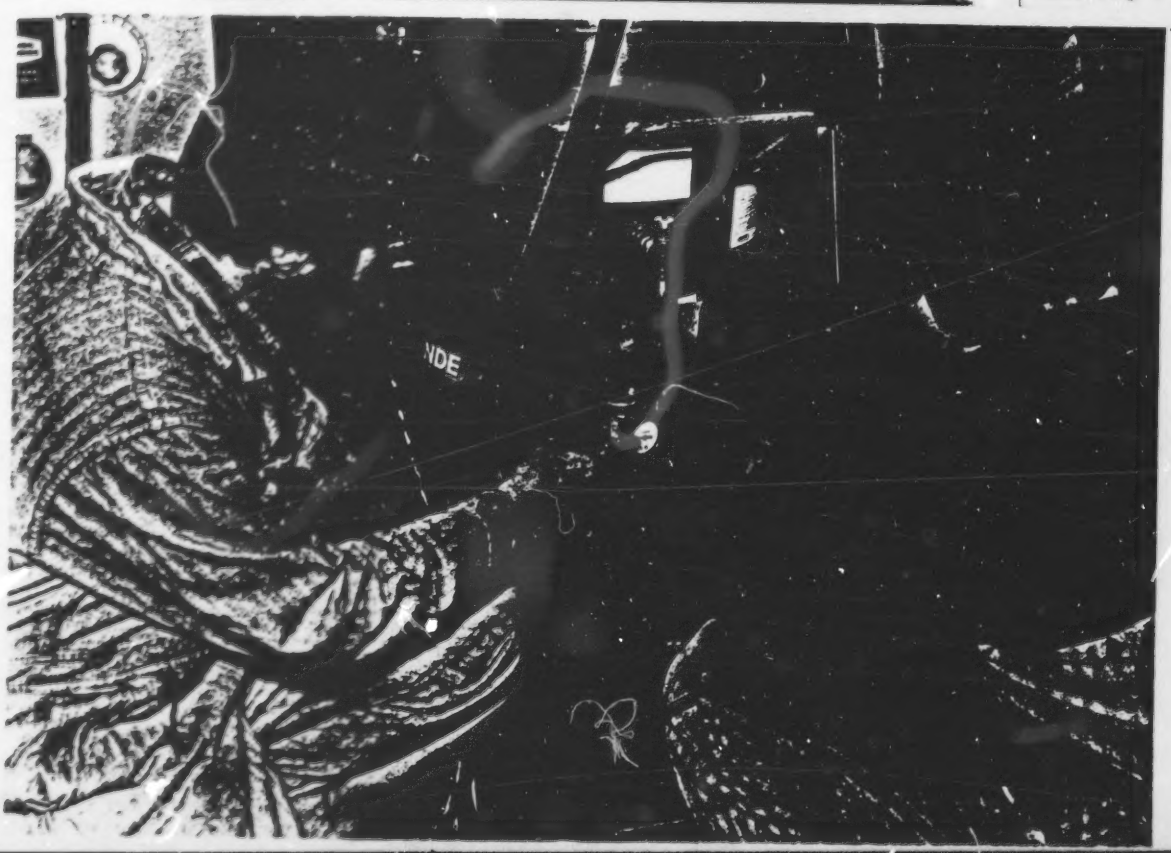
F - Photos

Welding T joint



Setting feed pressur

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F Photos

Dye penetrant test of weld

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CREDITS

This project which has clearly improved the Welding Training Program at Seattle Central Community College was only possible due to the ready assistance of the following personnel:

Mike Nakata and Jim Johnston, Todd Pacific Shipyard

Russ Warnock, Lockheed Shipbuilding & Construction Co.

Wayne Morris, Marine Construction & Design

Ralph Hansen, Marine Power & Equipment

Elmer Merck, Flohr Metal Fabricators, Inc.

Jack Klumb, Jeff Laing and Hap Bruce, Welders Supply Co.

Bob Burwell, Ace Tank & Equipment Co.

Bruce Browning, Hobart Bros. Arc Welding Systems

John Tucker, Lincoln Electric

Cory McCarty, Maltby Tank and Barge

Tim Hosselton, Leckenby Co.

Dr. Earl Bowick and Joanne McDevitt, Seattle Central C.C.

Rob Etchyson, Welders Service Inc.